Molasses

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Molasses can be produced from citrus, wood sugar, sugar beet and sugarcane. Here will be described the different types of molasses that can be produced from clarifying, concentrating and/or extracting sucrose from sugarcane juice in a raw sugar factory and from refining raw sugar in a sugar refinery, as well as their primary use in animal feeds. They are: integral or unclarified molasses, high-test molasses, A molasses, B molasses, C (final) molasses and syrup-off.

Integral high-test molasses is produced from unclarified sugarcane juice which has been partially inverted to prevent crystallization, then concentrated by evaporation until approximately 80% of DM content. Because it is concentrated from unclarified sugarcane juice, heavy incrustations and scum deposits lead to frequent mill interruptions and therefore to increased factory maintenance costs.

High-test molasses is basically the same as integral high-test molasses; however, since the sugarcane juice has been clarified before evaporation and therefore the impurities removed, the negative factors associated with integral high-test molasses are not present.

"A" molasses is an intermediate product obtained upon centrifuging the A masecuite in a raw sugar factory. Approximately 77% of the total, available, raw sugar in clarified/concentrated sugarcane juice is extracted during this first centifugation process. The "A" molasses, which is produced simultaneously with the "first" or "A" sugar, contains 80-85% of DM. If used immediately there is no need for partial inversion; however, if it is to be stored it must be partially inverted, otherwise it could crystallize spontaneously in the storage tanks.

"B" molasses is also known as "second" molasses. It, too, is an intermediate product, obtained from boiling together "seed-sugar" and

A molasses to obtain a B masecuite, which is then centrifuged to extract an additional 12% of raw sugar. At this point, approximately 89% of the total recoverable raw sugar in the processed cane has been extracted. B molasses contains 80-85% of DM and generally does not crystallize spontaneously; however, this depends on the purity of the original sugarcane juice and the temperature at which it is stored.

The last molasses is known as "C", "final" or "blackstrap" molasses and in some countries as "treacle". It is the end product obtained upon combining "virgin" sugar crystals obtained from syrup crystallization and B molasses to form a C masecuite, which after boiling and centrifuging produces C sugar and C molasses. Even though C molasses is considered the end or final product in a raw sugar factory, it still contains considerable amounts of sucrose (approximately 32 to 42%) which to date has not been recovered by an economically viable method.

Syrup-off, known also as "liquor-off" or "jett", is the end product obtained from the centrifugation of the final refined masecuite in a raw sugar refinery. Normally, syrup-off is sent to the raw sugar (front) section of the refinery where it is reprocessed in order to recover more sucrose. Due to its high content of sucrose, 90-92% of DM, it is an excellent energy source for monogastrics; however, it can be an expensive option. The decision would necessarily be of an economic nature, including the overall thermal balance of the refinery; it might pay to sacrifice sucrose to save bagasse, or another refinery energy source. Finally, in the process of refining raw sugar, another type of "final" molasses is obtained, called "refinery final molasses" representing less than 1% of processed raw sugar. Since it has a very similar composition to that of final molasses produced in a raw sugar factory, it is usually deposited in the C molasses tanks.

In some countries the juice is extracted in a simple animal or mechanical driven press, then boiled in open vats. In this rudimentary process no sucrose crystallization occurs, but rather as the undiluted juice is boiled, the impurities, the coagulated proteins and minerals, surface and are removed to produce a type of molasses called "melote" of 50% DM. The further boiling, and finally, incorporation of air into the masecuite produces "pan" sugar. In addition to the different types of liquid, cane molasses, dried C (final) molasses with 91% DM is a commercial feed ingredient.

There are approximately 60 countries that produce sucrose from sugarcane. Due to cane varieties, climate and different process technologies, the composition of the above described products can vary substantially. For example, in Cuba, the purity, ie, the relation of sucrose to the total DM of the cane juice, can be as high as 88%; in other countries this figure varies from 76 to 80 percent. An example of the importance of this factor could be the following: B molasses obtained from an initial juice of high purity has a very high probability of crystallizing during storage, whereas A or B molasses obtained from a juice of low purity (78-80%) will not crystallize during storage. These differences can be important when related to animal feeding systems.

Molasses is used basically as source of energy; it is free of fat and fibre with a low nitrogen content. The nitrogen free extract (NFE), the main fraction representing between 85-95% of the DM, is composed of a mixture of simple sugars and a non-sugar fraction. The non-sugar fraction is poorly digested and fermented in the gastrointestinal tract. It is the increasing amount of the non-sugar fraction in each successive type of molasses, from A to C, that determines the nutritional value of molasses for animal feeding. The amount of the non-sugar fraction as a percent of the total nitrogen free extract DM is: high-test, 9; A molasses, 18; Bmolasses, 23; and C molasses, 33 percent. The amino acids in molasses have not been considered due to their low content in the order of 0.5% of AD product. One gallon of syrup-off or A molasses weighs 5.3 Kg; the same amount of B and C molasses weighs 5.4 and 5.5 Kg, respectively.

Use: 1) low level

Final molasses is used to improve the palatability of dry feeds where it is often incorporated at levels of between 5 and 15% (AD) in the final mix. It is used between 5 and 8% as a binder in pellets and in pre-digested bagasse pith at a level of 15 percent. A solution of three parts of water to one of molasses can be sprayed by plane over parched grass or standing hay to improve palatability and/or leaf loss.

This same technique, but hand-sprayed, and with the possible addition of non-protein-nitrogen (NPN), is used to improve the palatability of sugarcane trash when used as a dry season, maintenance ration. Because molasses ferments quickly, it is sometimes added to a silo at a level of 5% to enhance the fermentative process, as well as to increase palatability. It can also be used at the rate of 50 Kg/m^2 as a sealant for horizontal silos.

The economics related to the commercial use of molasses, together with restricted by-pass protein for intensive beef production has been re-evaluated to the point where molasses, in either liquid or solid form, is currently promoted as a "carrier" for non-protein-nitrogen and other additives. Molasses is generally "more available and cheaper" when cattle and sheep are hungriest, ie, when grass is less green; however, when fed alone or mixed with only 3% of urea, its palatability is not affected and therefore it should be restricted to 2-3 Kg/head/day. If used as a carrier for higher concentrations of NPN, the bitterness of the urea in the molasses serves as an auto-regulator causing the cattle to consume about one kg/head/day. This formula is (AD): C molasses, 80-85%; urea, 10-15%; salt 2.5% and dicalcium phosphate, 5.5 percent.

Molasses can also be used as a supplement during the rainy season, where it serves to increase carrying capacity rather than improve performance; in this case, the energy obtained from forage is replaced by the more readily fermentable energy from the molasses. Caution must be taken when the spring rains begin; if the molasses is diluted it will rapidly ferment into alcohol and may fatally poison the cattle. As molasses/urea is deficient in phosphorus, it is necessary to add phosphoric acid to the mixture or provide the cattle with mineral supplementation. Drinking water must be available, constantly.

A multi-nutritional or molasses/urea block can be made by mixing together, and in the following order: final molasses, 50%; urea, 10%; salt, 5%; dicalcium phosphate, 5%; calcium hydroxide, 10% and lastly, 20% of a fibre source such as wheat middlings or dried, bagasse pith. Cement may be used instead of hydrated lime but it first must be mixed with 40% of its weight in water before adding it to the other ingredients. If possible, the NPN components should be 8% of urea and 2% of ammonium sulphate in order to include a source of sulphur for the rumen organisms. Sheep will consume between 150-180 grams/day and cattle approximately 500 g/day. The block should be with the animals a minimum of 16 hours daily, and preferably 24 hours.

Mixed in drinking water it is used to hydrate baby chicks during the first hours upon arrival from the hatchery. Finally, fresh fish or fish-offal, and snails can be preserved by mixing 50:50 with final molasses, then fed with B molasses to pigs, ducks and geese.

Use: 2) high level

A commercial beef fattening system, developed in Cuba and still used with modifications after more than 25 years, it is based on free-choice final molasses mixed with 3% of urea, restricted fish meal or another protein source, restricted forage (3 Kg /100 Kg LW) and free-choice mineral mix of 50% dicalcium phosphate and salt. The molasses/urea mixture, which represents some 70% of total diet DM, contains 91% final molasses and 6.5% water. The urea and salt are first dissolved in water before being mixed with the molasses; this mix is top-dressed, once daily, generally with 70g of bypass-protein (fishmeal) per 100 Kg of liveweight.

In a large, feedlot operation, the daily ration/head is calculated in terms of: 90g mineral mix, 250g fishmeal, 6 Kg molasses/urea and 10 Kg of forage. The ADG can be between 0.8 and 1.0 Kg with a DM conversion of between 10 and 12; however, under average feedlot conditions the gains are between 0.7 and 0.8 Kg/day.

Although molasses can completely replace cereals in a beef feedlot operation, such is not the case with milk production, particularly with high producing dairy cows. In this case, the molasses/milk system does not perform adequately. It has been postulated that the problem could be one of insufficient glucose precursors related to the digestion of the molasses, particularly since the demand for this nutrient is greater in milk than in beef.

When fed in large amounts, and incorrectly, molasses may be toxic. The symptoms of molasses toxicity are reduced body temperatures, weakness and rapid breathing. The animals usually have difficulty standing and try to lean against some support with their forelegs crossed. The remedy is to immediately give them a solution that is rich in phosphorus and sodium, and to take the animals off molasses feeding for a few days. The causes of molasses toxicity are most often a scarcity of drinking water in close proximity to where they are being fed or a too rapid switch-over to high molasses diets. A modification to this feeding system is to use restricted grazing, usually one and a half hours, twice daily.

After decades of intense research to improve the performance of swine fed high levels of final molasses, a solution promoted in the early 80's by the Cuban sugar industry, was to simply change from C molasses to B molasses; presently, that country uses more than 400 thousand tons of B molasses for animal feeds, annually. Gestating sows are fed a protein supplement and B molasses to represent 64% of the DM of the daily diet. The three basic fattening rations, in % DM, are: 1) treated organic wastes (33), dry ration (33) and B molasses (33); 2) protein supplement (53) and B molasses (47); and 3) "protein molasses": B molasses (70) and Torula yeast cream (30), which as an integral diet of 36% DM contains 14% CP in DM.

Poultry, particularly geese and ducks, can be fattened on liquid diets containing up to 60% DM of molasses, preferably high-test, A or B molasses. Theoretically, the same system, level and types of molasses work for broilers and layers, however the management factor is crucial. An on-farm, immediate-use, mixing system to include 18 to 24% DM of high-test, A or B molasses in dry feeds for poultry is possible.

Two unconventional feeding systems for rabbits using more than 35% molasses in DM are: 1) "protein molasses" mixed with wheat bran or sun-dried, ground, sugarcane to soak up moisture and 2) "macro- pellets", that use the basic idea of the molasses/urea block but without urea. The air-dry formula for the one kilogram "macro-pellet" is: B molasses or syrup-off, 45-50%; whole, toasted soybeans, 25%; mineral mix, 5%; hydrated lime, 8-10% and a source of fibre, 10-15 percent. Both feeding systems require an additional 50% DM of forage.

As % of dry matter

Type of molasses:	DM	CP	CF	Ash	EE	NFE	Ca	P	Ref
High-test, Cuba	85	1.3	0.0	2.8	0.0	95.7	0.5	0.03	383
A molasses, Cuba	77	1.9	0.0	4.6	0.0	93.6	0.62	0.03	"
B molasses, Cuba	78	2.5	0.0	7.2	0.0	90.4	0.80	0.04	"
C molasses, Cuba	83	2.9	0.0	9.8	0.0	87.4	1.21	0.06	"
C molasses, Uganda	74	4.2	0.0	8.6	0.0	87.2	0.71	0.07	69
Syrup-off, Cuba(a)	75	0.8	0.0	1.3	0.0	98.0	1.15	0.07	602
Melote, Colombia(b)	50	-	-	-	-	88.0	-	-	603

(a) from refinery; (b) from "pan" sugar ("panela")

Digestibility, %

	Animal	ME	DM	NFE	Ref
C molasses	sheep	10.9	-	83	263
	cattle	8.8	-	-	604
	pig	11.8	81	89	602
	poultry	8.4	-	-	605
High-test	pig	13.6	96	98	602
A molasses	pig	12.8	94	96	"
B molasses	pig	12.3	90	92	"